

1 **CLAIMS**

2 What is claimed is:

3
4 1. A computer-implemented method for processing video data
5 comprising:

6 determining an ideal playback timing associated with the video data; and
7 if an actual playback timing of the video data lags the ideal playback
8 timing, varying a frame rate associated with the video data using a smoothing
9 function to recover toward the ideal playback timing.

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11 2. The computer-implemented method as recited in Claim 1, wherein
12 smoothly varying the frame rate includes controlling the frame rate using a frame-
13 dropping algorithm that drops frames in the video data in accordance with the
14 smoothing function.

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16 3. The computer-implemented method as recited in Claim 2, wherein
17 controlling the frame rate includes:

18 computing a delay by comparing the actual playback timing with the ideal
19 playback timing; and

20 if the delay exceeds a threshold value, determining that the actual playback
21 timing lags the ideal playback timing.

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23 4. The computer-implemented method as recited in Claim 3, wherein
24 the threshold value accounts for ordinary system variations.

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2 5. The computer-implemented method as recited in Claim 3, wherein
3 the delay is computed by subtracting the ideal playback timing from the actual
4 playback timing.

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6 6. The computer-implemented method as recited in Claim 3, wherein
7 the smoothing function incorporates the delay as a variable.

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9 7. The computer-implemented method as recited in Claim 3, wherein
10 the delay is computed as an average delay that includes an average of the delay
11 associated with a current frame of the video data and at least a delay associated
12 with a previous frame.

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14 8. The computer-implemented method as recited in Claim 7, wherein
15 the average delay is an average of delays associated with the current frame and a
16 plurality of previous frames.

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18 9. The computer-implemented method as recited in Claim 2, wherein
19 the frame-dropping algorithm includes a rasterization algorithm.

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21 10. The computer-implemented method as recited in Claim 2, wherein
22 the frame-dropping algorithm includes if a current frame is a B-frame, dropping
23 the current frame.

1 11. The computer-implemented method as recited in Claim 2, wherein
2 the frame-dropping algorithm includes if a current frame is an I-frame, showing
3 the current frame without further determination.

4
5 12. The computer-implemented method as recited in Claim 2, wherein
6 the frame-dropping algorithm includes if a current frame is a P-frame, processing
7 the current frame to obtain enough information for processing subsequent frames
8 before dropping the current frame.

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10 13. The computer-implemented method as recited in Claim 2, wherein
11 the frame-dropping algorithm includes if the actual playback timing does not lag
12 the ideal playback timing, overriding any determination to drop frames.

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14 14. The computer-implemented method as recited in Claim 1, wherein
15 the ideal playback timing is determined from a presentation clock.

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17 15. The computer-implemented method as recited in Claim 14, wherein
18 the presentation clock includes a filter configured to remove noise.

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20 16. One or more computer-readable memories containing a computer
21 program that is executable by a processor to perform the computer-implemented
22 method recited in Claim 1.

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1 17. A computer-implemented method for managing video data frame
2 rates comprising:

3 determining delays associated with playback of frames of video data;

4 calculating an average delay from averaging the delays;

5 determining an ideal frame rate associated with the frames;

6 calculating a frame skip factor; and

7 varying the frame rates associated with the playback by applying a frame-
8 dropping algorithm configured to determine whether to drop a current frame using
9 the frame skip factor.

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11 18. The computer-implemented method as recited in Claim 17, wherein
12 the frame skip factor is calculated with a tolerance factor that accounts for
13 variability in a system timer.

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15 19. The computer-implemented method as recited in Claim 17, wherein
16 the frame-dropping algorithm includes an iterative algorithm that varies the frame
17 rates using a smoothing function that includes the frame skip factor.

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19 20. The computer-implemented method as recited in Claim 17, wherein
20 the frame-dropping algorithm includes:

21 if the frame skip factor is greater than the ideal frame rate, adding the ideal
22 frame rate to an iterator; and

23 if the iterator is greater than or equal to the frame skip factor, subtracting
24 the frame skip factor from the iterator and showing the current frame.

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2 21. The computer-implemented method as recited in Claim 20, wherein
3 the frame-dropping algorithm includes if the iterator is less than the frame skip
4 factor, dropping the current frame.

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6 22. The computer-implemented method as recited in Claim 21, wherein
7 the frame-dropping algorithm includes:

8 if the iterator is less than the frame skip factor, determining whether the
9 average delay has reached a significant percentage of a maximum delay; and
10 if so, showing the next I-frame subsequent to the current frame.

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12 23. The computer-implemented method as recited in Claim 17, wherein
13 priority is given to the execution of the computer-implemented method to improve
14 the quality associated with the calculated frame rates.

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16 24. One or more computer-readable memories containing a computer
17 program that is executable by a processor to perform the method recited in Claim
18 17.

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20 25. An apparatus comprising:
21 means for determining an ideal playback timing associated with the video
22 data; and
23 means for varying a frame rate associated with the video data using a
24 smoothing function to recover toward the ideal playback timing.

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2 26. The apparatus as recited in Claim 25, further comprising means for
3 controlling the frame rate using a frame-dropping algorithm that drops frames in
4 the video data in accordance with a smoothing function.
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6 27. The apparatus as recited in Claim 26, further comprising means for
7 buffering the video data so that the frame-dropping algorithm is executing ahead
8 of real time.
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10 28. The apparatus as recited in Claim 26, further comprising means for
11 incorporating a rasterization algorithm into the frame-dropping algorithm.
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13 29. The apparatus as recited in Claim 25, further comprising:
14 means for computing a delay by comparing an actual playback timing with
15 the ideal playback timing; and
16 means for incorporating the delay into the smoothing function.
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18 29. The apparatus as recited in Claim 25, further comprising:
19 means for computing an average delay associated with playback of a
20 plurality of frames; and
21 means for incorporating the average delay into the smoothing function.
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1 30. One or more computer-readable media having stored thereon a
2 computer program that, when executed by one or more processors, causes the one
3 or more processors to:

4 determine an ideal playback timing associated with video data; and

5 if an actual playback timing of the video data lags the ideal playback
6 timing, vary a frame rate associated with the video data using a smoothing
7 function to recover toward the ideal playback timing.

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9 31. One or more computer-readable media as recited in Claim 30,
10 wherein the frame rate is smoothly varied by applying a frame-dropping algorithm
11 that drops frames in the video data in accordance with the smoothing function.

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13 32. One or more computer-readable media as recited in Claim 31,
14 wherein the frame-dropping algorithm includes:

15 computing an average delay by averaging delays associated with frames in
16 the video data, and

17 incorporating the average delay into the smoothing function.

18
19 33. An electronic device comprising:

20 a memory; and

21 a processor coupled to the memory, the processor being configured to

22 determine an ideal playback timing associated with video data; and
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1 if an actual playback timing of the video data lags the ideal playback
2 timing, vary a frame rate associated with the video data using a smoothing
3 function to recover toward the ideal playback timing.

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5 34. The electronic device as recited in Claim 33, wherein the processor
6 being further configured to apply a frame-dropping algorithm that drops frames in
7 the video data in accordance with the smoothing function.

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9 35. The electronic device as recited in Claim 33, wherein the processor
10 being further configured to compute an average delay by averaging delays
11 associated with frames in the video data and incorporate the average delay into the
12 smoothing function.